

AC 2007-274: PROJECT-DIRECTED MATHEMATICS

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Since Fall 2004, Jean Hodges has been an Assistant Professor of Writing and Writing Center Instructor at Virginia Commonwealth University Qatar in Doha, Qatar. She has published two recent articles: "Two Separate Cultures and Freedoms," published in the University of Richmond International Education Newsletter in Spring 2005 and "Young Speaks on Cities," written for the University of Richmond Magazine in 2001. Her most recent collection of poems, a booklet designed and illustrated by Aida Hashim and entitled Grains of Sand Upon the Desert Floor, appeared in the VCUQ Seventh Annual Faculty Exhibition held in 2005. In addition to publishing articles and writing poetry she presented several professional workshops and papers, the most recent of which, "Making Connections Among Culture, Personality, and content in Analytical Courses," co-authored with Dr. John Schmeelk at the April 2006 meeting of Middle East Teachers of Science, Mathematics and Computing (METSMaC) in Abu Dhabi.

PROJECT-DIRECTED MATHEMATICS

Abstract

The authors examine the learning preferences work of Ricki Linksman, founder of the National Reading Diagnostic Institute in the United States and author of *How to Learn Anything Quickly*. In an earlier study, they theorized that female MATH 131 students at Virginia Commonwealth University Qatar (VCUQ) were probably visual and tactile right-brained learners based on their artistic interests in three design majors and the characteristics of these types of learning preferences. In this study, they test the learning and hemispheric preferences of MATH 131 students and, because visual and tactile learners learn best by seeing and touching, hypothesize that centering mathematics instruction on projects completed either individually or collaboratively (*project-directed mathematics*) will facilitate students' learning better than will traditional lectures and problem-solving assignments.

The projects are focused on the design and implementation of both individual and group activities that engage students in high-level thinking and mathematical problem solving. As a team the professor and students discuss deeper mathematical properties illustrated within the students' projects. As design majors, the students are very motivated to create unique projects that draw upon their artistic talent and creativity. Combined with a "mathematical spin" required by the professor, these projects offer a pilot for mathematical understanding. Preliminary results indicated that the project-directed approach is more successful than the traditional lecture and problem-solving techniques because students are eager both to collaborate with their peers and professor and to compete against each other in developing the most creative projects.

Introduction

During the academic years 2003-2006, Dr. Schmeelk instructed several sections of a contemporary mathematics course in Doha, Qatar, a small peninsula of 4,400 square miles extending into the Persian Gulf and attached to Saudi Arabia. The size is comparable to the state of Connecticut in the United States. The population is approximately 770,000, and its leader is His Highness Sheikh Hamad Bin Khalifa Al Thani, Emir of Qatar. In 1997 Virginia Commonwealth University, located in Richmond, Virginia, USA, (VCUR) and Qatar's Emir collaborated to form the Shaqab College of Design Art located in Doha, Qatar, and primarily supervised by Qatar Foundation, an organization chaired by Her Highness Sheikha Mozah Bint Nasser Al Missned. In 2002 the school was officially renamed Virginia Commonwealth University Qatar and began to operate more fully under the direction of VCUR.

Within the curriculum for design students in both VCUR and VCUQ, one general education requirement for all students is a contemporary mathematics course (MATH 131). Tailoring this course to fit the unique needs and interests of VCUQ majors became a unique and exciting challenge that gave rise to the authors' 2006 study entitled, "Making Connections Among Culture, Personality, and Content in Analytical Courses," which was presented at the March 2006 Conference of Middle Eastern Teachers of Science, Mathematics, and Computing.

In their previous study, the authors relied upon the work of Ricki Linksman, an expert in accelerated learning who founded the National Reading Diagnostic Institute in the United States and who popularized her research on accelerated learning in *How to Learn Anything Quickly*. Basically, Linksman claims that students learn best when new material is presented in ways that appeal to their favorite learning style (visual, auditory, tactile, or kinesthetic) and brain hemispheric preference (i.e., right-brain, left-brain, mixed, or integrated preference). The combination of learning style and hemispheric preference favored by an individual is known as that person's "super link," according to Linksman, and appealing to someone's super link is the fastest way for that person to learn.

In the previous study of MATH 131, the authors deduced that the majority of the students would be right-brained visual or tactile learners based on observations of design students' characteristics and Linksman's definitions of these super links. This study set out to test that deduction by recording students' super links after administering Linksman's tests for determining learning style and brain hemispheric preferences (see Appendices A and B). The tests were given early in the term shortly after introducing the course and its project-directed concept, and the results were discussed with the students, who also received handouts of Linksman's characterizations for each of the learning styles and brain hemispheric preferences.

Because Arabic art and architecture are strongly influenced by geometrical designs, MATH 131 includes several chapters of the mathematical text⁶ that expand upon rotations, reflections, and translations. In addition, the course begins with mathematical formulas that speak to this issue of geometric shapes, followed by an intense development of the Fibonacci sequence and several of its properties illustrating the utility of the sequence in the "real world." In this study, students were shown some past student projects submitted as partial fulfillment in the previous MATH 131 courses to introduce each new topic visually and were required to complete a much more comprehensive project component (hence the term *Project-Directed Mathematics*). The students were very much impressed by the past projects and wanted to compete with each other to find new projects that illustrate mathematical principles. The authors demonstrate and illustrate the procedures for several of these course topics, beginning with sequences and series.

Sequences, Series, and Fibonacci Numbers

The Fibonacci sequence is presented as the first sequence since it enjoys such a rich history. The professor and students consider Fibonacci as an Italian mathematician, and the students research him on the web. The topic is introduced by showing the Leaning Tower of Pisa to place the mathematician in an Italian setting (see Fig. 1 below). This is followed by a discussion of the Fibonacci sequence (1, 1, 2, 3, 5, 8, 13, 55, ...) and illustrated with past students' projects on the topic. One past project is posters used to motivate computing and working problems on the white board (see Fig. 2).



Fig. 1: The Leaning Tower of Pisa



Fig. 2: Prior Students' Fibonacci Sequence Posters

Another sample project was produced by a student in Spring 2006 who named it "The Fibonacci Tower" (Fig. 3). In this tower, the idea is that each level is approximated to be 1, 1, 2, 3, 5, 8, and 13 square inches. When they saw this project, several students commented that "I didn't know what these numbers mean, and now I know I understand them." One design student indicated that a fountain to be built in Doha on the Corniche should be termed the "Fibonacci Fountain." This comment stimulated presenting a picture of an existing "Fibonacci Fountain" to the class (Fig. 4) and motivated several students to design their own "Fibonacci Fountains."

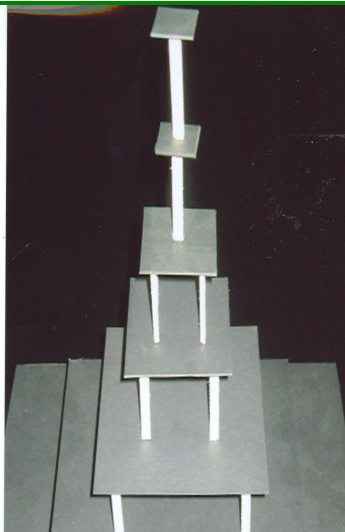


Fig. 3: One student's project, "The Fibonacci Tower"



Fig. 4: Glass fountain designed by Gianluca Adami, Aspromonte Park, Italy

The Fibonacci numbers also occur in nature. Schilling and Harris’s chart shown in Table 1 and a painting of three-petaled irises shown in Fig. 5 illustrate the presence of the Fibonacci sequence in flowers. The Nautilus sea shell (Fig. 6) shape is a spiral which can be drawn using a rectangular coordinate system whereby the box lengths are 1, 1, 2, 3, 8, 13, ... millimeters. One student illustrated this with her project shown in Fig. 7, “The Fibonacci Spiral.” In this project, two squares, each 1 mm long, are drawn side by side, and then another square, 2 mm long, is drawn below the two original squares. A fourth square 3 mm long is drawn to the left side of all three squares. Continuing in this fashion and connecting each square with a spiral line completes the Fibonacci Spiral.

Fibonacci Sequence

Reference: Digital Signal Processing
Robert J. Schilling & Sandra Harris

Iris	3 petals
Wild Rose	5 petals
Delphinium	8 petals
Corn Marigold	13 petals
Aster	21 petals
Pyrethrum	34 petals
Michaelmas Daisy	55 petals



Table 1: Flower petals show the Fibonacci Sequence

Fig. 5: A painting of irises



Fig. 6: A chambered nautilus

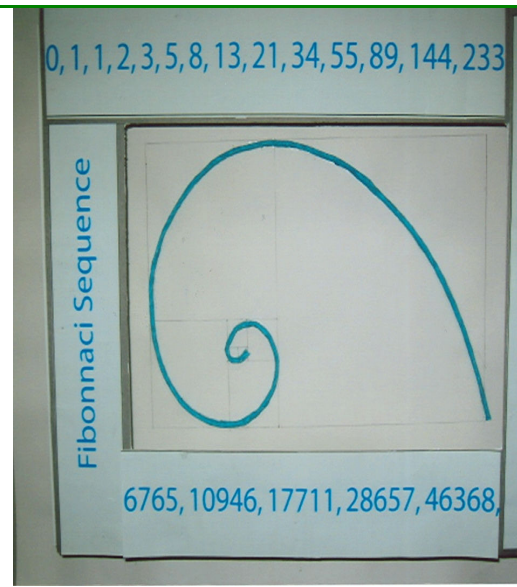


Fig. 7: A student’s “Fibonacci Spiral”

The next topic is the “Golden Number,” often termed “The Divine Proportion,” leading to the golden rectangle. The book, *The Golden Ratio*⁵, refers to The Divine Proportion, as the Golden Number is used as a reference during the development of this topic. The Golden Number,



Fig. 8: A student's poster illustrating Fibonacci numbers



Fig. 9: A student's poster illustrating The Golden Number

$(1 + \sqrt{5})/2$, approximated to be 1.61803..., can be found in lectures on art history, architecture, and numerous other places. This topic generates much student discussion. Two project posters (Figs. 8 and 9) illustrate some features using The Golden Number and Fibonacci numbers.

Symmetry

Symmetry is motivated by several photos illustrating Doha's mosques. Figures 10, 11, and 12 are pictures of Doha mosques about 75 years, 45 years, and 10 years of age, respectively. Being mostly Arab Muslims, the students can immediately identify symmetry found in the mosques. Since all the men in their families are obliged to go to the mosque five times daily, the young women are constantly exposed to mosque life and also are encouraged to attend mosque with their families and friends whenever possible. (Attendance obligations differ for men and women.)

The reference book, *Architecture of the Islamic World*², was circulated among the students so they could observe architectural structures designed by Islamic architects. The illustrations in

the book precipitate the students' understanding of Islamic architects' extensive use of structural symmetry. The hope is that the students would be motivated to understand the underlying principles displayed in the mosques and other buildings containing so much symmetry in Qatar.



Fig. 10: One of the oldest Doha mosques, about 75 years old



Fig. 11: A Doha mosque, about 45 years old



Fig. 12: A modern Doha mosque showing Spanish influence (about 10 years old)



Fig. 13: A symmetrical lighting fixture inside a mosque

A mosque lighting fixture (Fig. 13) is shown to the students, since a lighting course is required for interior design students, as the starting point to present the symmetric notions of rotations, reflections, and glide reflections. The concepts of rotations and reflections are presented in the text, implementing the notation D_n to indicate symmetry having exactly n rotations combined with exactly n reflections. The notation Z_n indicates exactly n rotations and no reflections. Notational requirements present problems to most novice math students, but MATH 131 students relate these ideas clearly and concisely when working with projects. Student projects on symmetry using these notational conventions are shown in Figures 14-17.

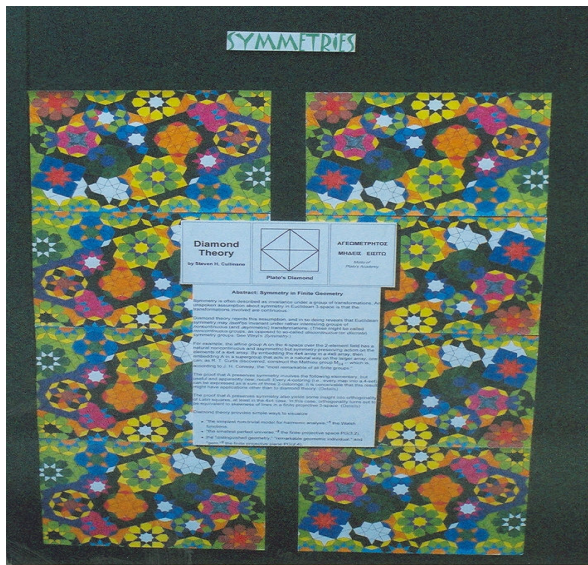


Fig. 14: A student's project on symmetry



Fig. 15: A student's multi-poster project on symmetry

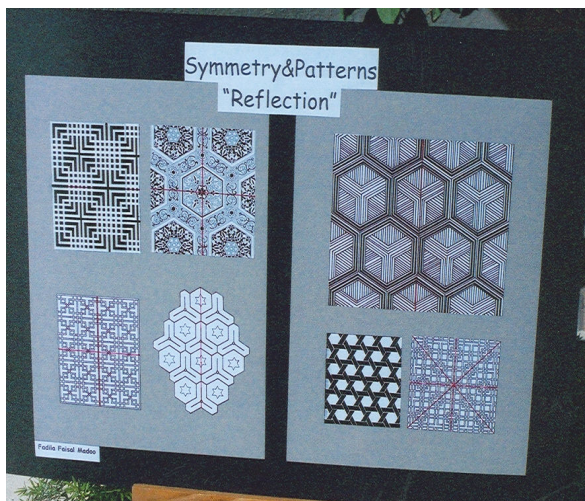


Fig 16: Student project on symmetrical patterns and reflections



Fig. 17: A student's project illustrating symmetry in the design of kick plates on a stairway

Fractals

The journey through fractal designs begins with showing first a fractal contained within a fractal gallery located on the web (Fig. 18) and then several fractal calendars created by previous MATH 131 students (Fig. 19).

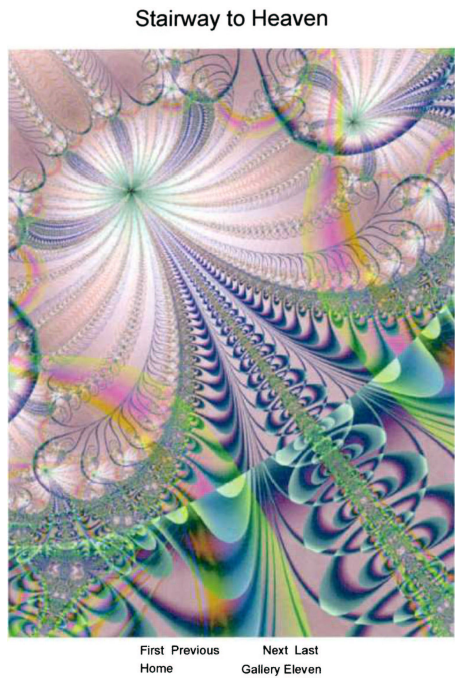


Fig. 18: A famous fractal from a web site

Fig. 19: Sample calendars by previous MATH 131 students

The students collaborate to investigate various fractal galleries found on the web, and then professor and students develop The Koch Snowflake, Anti Koch Snowflake, and Serpinski Gasket. Worksheets guide students to carefully examine the recursive formulas used in fractal

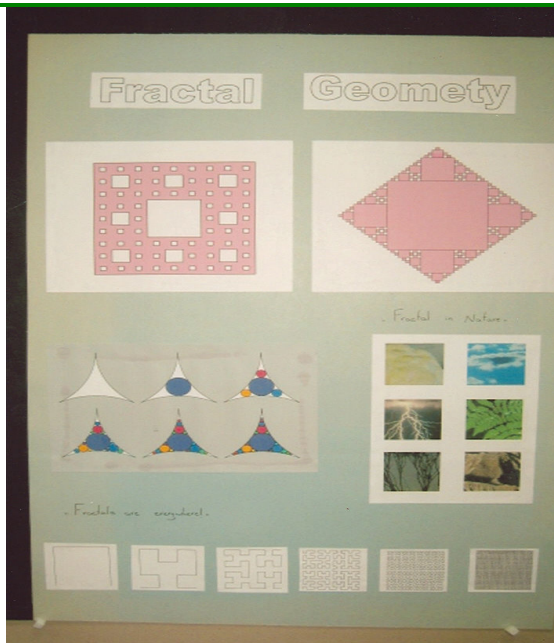


Fig. 20: A student's poster explaining the geometry of fractals

Fig. 21: Calendars designed by MATH 131 students using fractal illustrations

development, and students build the snowflakes and Serpinski gaskets to better understand the recursive formulas for number of edges, perimeters, areas, etc. This method is somewhat successful and requires concentration and careful development by the student, yet several students selected the snowflake and fractal calendars for their projects, which are shown in Figures 20-23.



Fig. 22: Development of a Koch Snowflake illustrated by one student



Fig. 23: Calendars designed by MATH 131 students

The Mandelbrot set (Fig. 24) is carefully examined, and the mathematical technique is studied implementing both real and complex numbers. This allows students to introduce artistic development by employing colors for the escaping, periodic, and attracting sequences within the fractal. Work in progress involves using software to create some interesting fractals. Worksheets also help students examine carefully the recursive formulas used in the fractal development. The Mandelbrot set allows students to compute with real and complex numbers. Again, the students can introduce artistic creativity by employing hot and cool colors for the escaping, periodic, and attracting sequences within the Mandelbrot fractal.

The course concludes with a very brief introduction of graph theory. Several topics are developed from graph theory, such as Euler and Hamilton graphs. The map shown in Figure 25 helps students visualize the famous Konigsberg five-bridge problem. We also cover the famous Kruskal's algorithm, which can select the best route on a graph to maximize profit. The algorithm is demonstrated in the student's project shown in Figure 26. The project implements the algorithm by finding the least expensive route to maximize profit to ship cargo from Doha to several neighboring airports.

Results

The results of MATH 131 students' learning style and hemispheric preference tests documented that students' actual super links were not as anticipated. The authors expected design students to prefer primarily visual and tactile styles with a right hemispheric preference. Instead, students



Fig. 24: A Mandelbrot Set

scored highest in visual preference (50 percent), next highest in kinesthetic preference (25 percent), third in tactile preference (16.67 percent), and lowest in auditory preference (8.33 percent).

Surprisingly, the majority of students exhibited *left* brain preferences (50 percent) with only 42 percent having the expected right brain preference. (Eight percent exhibited a mixed preference, using the two hemispheres interchangeably for different tasks.) Left-brain learners process information linearly and prefer working with symbolic language, such as numbers, which is advantageous for studying math. On the other hand, right-brain learners think globally, connect seemingly unrelated ideas, and are extremely creative, all characteristics expected of design students.

In follow-up surveys and interviews with students about the course content and methods, the authors learned that 100 percent of students found the sample projects “helpful” or “very helpful.” However, students expressed mixed preferences when given a choice between taking a test and producing a project, and their preferences, surprisingly, usually favored taking the test.

Conclusions

Although the majority of MATH 131 design students were visual learners, as anticipated, the numbers who preferred a kinesthetic style involving muscles and movement were unexpected. Instead, the authors did expect tactile, or hands-on, preferences but underestimated the movement preference that would overshadow students’ tactile tendencies. From this standpoint,

allowing students to handle and examine sample projects and to create their own projects is an effective learning tool for design students taking MATH 131.

- (a) If a graph has *any* vertices of odd degree, then it *cannot* have an Euler circuit.
- (b) If a graph is *connected* and *every* vertex has an even degree, then it has at least one Euler circuit (and usually more).



EULER'S THEOREM 2

- (a) If a graph has *more than two* vertices of odd degree, then it cannot have an Euler path.
- (b) If a graph is *connected* and has just *two* vertices of odd degree, then it has at least one Euler path (and usually more). Any such path must start at one of the odd-degree vertices and end at the other one.

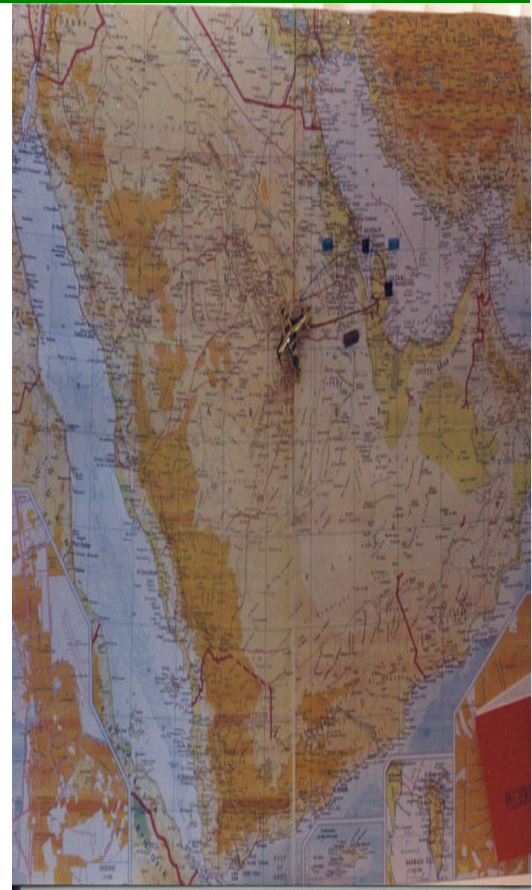


Fig. 25: Map of Königsberg illustrating its bridges

Fig. 26: A student's project on Kruskal's algorithm

While students' responses strongly favored the sample projects, their preference for taking a test rather than creating their own projects was surprising given their visual and kinesthetic learning style preferences. One explanation may lie in the high number of left brain hemispheric preferences, which would find the linear style of a test more appealing. Another explanation may be that design students find themselves creating numerous projects in their design courses, so the novelty of creating projects is diminished, and producing numerous projects may make completion time a serious consideration when students are faced with creating yet another required project. In addition, although the tradition is changing, pre-college Qatari students traditionally have learned by rote memorization and recitation, so test-taking may represent a familiar habit that is preferable to unfamiliar creative requirements. Finally, because classes are small (usually 8 to 12 students) and naturally collaborative (a cultural norm), one ringleader student may influence other students' choices by expressing her preference. More research is needed to determine the actual factors resulting in this choice.

Appendix A

Dr. John Schmeelk
MATH 131
Fall, 2006

NAME: _____

Project-Directed Mathematics

Learning Style Preference Assessment

*Please circle the letter of the answer that BEST fits you most of the time. **Please give only ONE best-for-you answer for each question.** If you do not understand a word or a question, please ask your instructor for help. This test is designed to help you learn your own preferences, so there are no right or wrong answers. Answering as truthfully as you can will give you a more accurate picture of your own learning style.*

1. When you meet a new person, what do you FIRST notice about him or her?
 - A. What he or she looks like and how he or she dresses
 - B. How the person talks; what he or she says; or his or her voice
 - C. How you feel about the person
 - D. How the person acts or what he or she does

2. Days after you meet a new person, what do you remember the most about that person?
 - A. The person's face
 - B. The person's name
 - C. How you felt being with the person even though you may have forgotten the name or face
 - D. What you and the person did together even though you may have forgotten the name or face

3. When you enter a new room, what do you notice the most?
 - A. How the room looks
 - B. The sounds or discussion in the room
 - C. How comfortable you feel emotionally or physically in the room
 - D. What activities are going on and what you can do in the room

4. When you learn something new, which way do you need to learn it?
 - A. A teacher gives you something to read on paper or on the board and shows you books, pictures, charts, maps, graphs, or objects, but there is no talking, discussion, or writing
 - B. The teacher explains everything by talking or lecturing and allows you to discuss the topic and ask questions, but does not give you anything to look at, read, write, or do
 - C. The teacher lets you write or draw the information, touch hands-on materials, type on a keyboard, or make something with your hands

- D. The teacher allows you to get up to do projects, simulations, experiments, play games, role-play, act out real-life situations, explore, make discoveries, or do activities that allow you to move around to learn
5. When you teach something to others, which of the following do you do?
- A. You give them something to look at, like an object, picture, or chart, with little or no verbal explanation or discussion
 - B. You explain it by talking but do not give them any visual materials
 - C. You draw or write it out for them or use your hands to explain
 - D. You demonstrate by doing it and have them do it with you
6. What type of books do you prefer to read?
- A. Books that contain descriptions to help you see what is happening
 - B. Books containing factual information, history, or a lot of dialogue
 - C. Books about characters' feelings and emotions, self-help books, books about emotions and relationships, or books on improving your mind or body
 - D. Short books with a lot of action, or books that help you excel at a sport, hobby, or talent
7. Which of the following activities would you prefer to do in your free time?
- A. Read a book or look at a magazine
 - B. Listen to an audiotaped book, a radio talk show, or listen to or perform music
 - C. Write, draw, type, or make something with your hands
 - D. Do sports, build something, or play a game using body movement
8. Which of the following describes how you can read or study best?
- A. You can study with music, noise, or talking going on because you tune it out
 - B. You cannot study with music, noise, or talking going on because you cannot tune it out
 - C. You need to be comfortable, stretched out, and can work with or without music, but negative feelings of others distract you
 - D. You need to be comfortable, stretched out, and can work with or without music, but activity or movement in the room distracts you
9. When you talk with someone, which way do your eyes move? (You can ask someone to observe you to help you answer this question.)
- A. You need to look directly at the face of the person who is talking to you, and you need that person to look at your face when you talk
 - B. You look at the person only for a short time, and then your eyes move from side to side, left and right
 - C. You only look at the person for a short time to see his or her expression; then you look down or away
 - D. You seldom look at the person and mostly look down or away, but if there is movement or activity, you look in the direction of the activity

10. Which of the following describes you best?
- A. You notice colors, shapes, designs, and patterns wherever you go and have a good eye for color and design
 - B. You cannot stand silence, and when it is too quiet in a place, you hum, sing, talk aloud, or turn on the radio, television, audiotapes, or CD's
 - C. You are sensitive to people's feelings; your own feelings get hurt easily; you cannot concentrate when others do not like you, and you need to feel loved and accepted in order to work
 - D. You have a hard time sitting still in your seat and need to move a lot, and if you do have to sit you will slouch, shift around, tap your feet, or kick or wiggle your legs a lot
11. Which of the following describes you the best?
- A. You notice when people's clothes do not match or their hair is out of place and often want them to fix it
 - B. You are bothered when someone does not speak well and are sensitive to the sounds of dripping faucets or equipment noise
 - C. You cry at the sad parts of movies or books
 - D. You are restless and uncomfortable when forced to sit still and cannot stay in one place too long
12. What bothers you the most?
- A. A messy, disorganized place
 - B. A place that is too quiet
 - C. A place that is not comfortable physically or emotionally
 - D. A place where there is no activity allowed or no room to move
13. What bothers you the most when someone is teaching you?
- A. Listening to a lecture without any visuals to look at
 - B. Having to read silently with no verbal explanation or discussion
 - C. Not being allowed to draw, doodle, touch anything with your hands, or take written notes, even if you never look at your notes again
 - D. Having to look and listen without being allowed to move
14. Think back to a happy memory from your life. Take a moment to remember as much as you can about the incident. After reliving it, what memories stand out in your mind?
- A. What you saw, such as visual descriptions of people, places, and things
 - B. What you heard, such as dialogue and conversation; what you said; and the sounds around you
 - C. Sensation on your skin and body and how you felt physically and emotionally
 - D. What actions and activities you did, the movements of your body, and your performance
15. Recall a vacation or trip you took. For a few moments remember as much as you can about the experience. After reliving the incident, what memories stand out in your mind?
- A. What you saw, such as visual descriptions of people, places, and things

- B. What you heard, such as dialogue and conversation; what you said, and the sounds around you
 - C. Sensation on your skin and body and how you felt physically and emotionally
 - D. What actions and activities you did, the movements of your body, and your performance
16. Pretend you have to spend all your time in one of the following places where different activities are going on. In which one would you feel the most comfortable?
- A. A place where you can read; look at pictures, art work, maps, charts, and photographs; do visual puzzles, such as mazes, or find the missing portion of a picture; play word games, such as Scrabble or Boggle; do interior decoration, or get dressed up
 - B. A place where you can listen to audiotaped stories, music, radio or television talk shows or news; play an instrument or sing; play word games out loud, debate, or pretend to be a disc jockey; read aloud or recite speeches or parts from a play or movie, or read poetry or stories aloud
 - C. A place where you can draw, paint, sculpt, or make crafts; do creative writing or type on a computer; do activities that involve your hands, such as playing an instrument; play games such as chess, checkers, or board games; or build models
 - D. A place where you can do sports, play ball or action games that involve moving your body, or act out parts in a play or show; do projects in which you can get up and move around; do experiments or explore and discover new things; build things or put together mechanical things; or participate in competitive team activities
17. If you had to remember a new word, would you remember it best by:
- A. Seeing it?
 - B. Hearing it?
 - C. Writing it?
 - D. Mentally or physically acting out the word?

TOTAL ANSWERS MARKED A: _____

TOTAL ANSWERS MARKED B: _____

TOTAL ANSWERS MARKED C: _____

TOTAL ANSWERS MARKED D: _____

Your preferred learning style is: _____

The Brain Hemispheric Preference Assessment

Please circle the letter of the answer that *BEST* fits you most of the time. **If both answers suit you equally well in this section, CIRCLE BOTH A AND B.** If you do not understand a word or a question, please ask your instructor for help. Remember, this test is designed to help you learn your own preferences, so there are no right or wrong answers. Answering as truthfully as you can will give you a more accurate picture of your own hemispheric preference.

1. Close your eyes. See red. What do you see?
 - A. The letters *r-e-d* or nothing because you could not visualize it
 - B. The color red or a red object

2. Close your eyes. See three. What do you see?
 - A. The letters *t-h-r-e-e*, or the number 3, or nothing because you could not visualize it
 - B. Three animals, people, or objects

3. If you play music or sing:
 - A. You cannot play by ear and must read notes
 - B. You can play by ear if you need to

4. When you put something together:
 - A. You need to read and follow written directions
 - B. You can use pictures and diagrams or just jump in and do it without using directions

5. When someone is talking to you:
 - A. You pay more attention to words and tune out their nonverbal communication
 - B. You pay more attention to nonverbal communication, such as facial expressions, body language, and tones of voice

6. You are better at:
 - A. Working with letters, numbers, and words
 - B. Working with color, shapes, pictures, and objects

7. When you read fiction, do you:
 - A. Hear the words being read aloud in your head?
 - B. See the book played as a movie in your head?

8. Which hand do you write with?
 - A. Right hand
 - B. Left hand

9. When doing a math problem, which way is easiest for you?
 - A. To work it out in the form of numbers and words
 - B. To draw it out, work it out using hands-on materials, or use your fingers

10. Do you prefer to:
 - A. Talk about your ideas?
 - B. Do something with real objects?
11. How do you keep your room or your desk?
 - A. Neat and organized
 - B. Messy or disorganized to others, but you know where everything is
12. If no one is telling you what to do, which is more like you?
 - A. You do things on a schedule and stick to it
 - B. You do things at the last minute or in your own time, and/or want to keep working even when time is up
13. If no one were telling you what to do:
 - A. You would usually be on time
 - B. You would often be late
14. You like to read a book or magazine:
 - A. From front to back
 - B. From back to front or by skipping around
15. Which describes you best?
 - A. You like to tell and hear about events with all of the details told in order
 - B. You like to tell the main point of an event, and when others are telling you about an event you get restless if they do not get to the main idea quickly
16. When you do a puzzle or project, do you:
 - A. Do it well without seeing the finished product first?
 - B. Need to see the finished product before you can do it?
17. Which method of organizing notes do you like best:
 - A. Outlining or listing things in order?
 - B. Making a mind map, or web, with connected circles?
18. When you are given instructions to make something, if given the choice, would you:
 - A. Prefer to follow the instructions?
 - B. Prefer to think of new ways to do it and try it a different way?
19. When you sit at a desk, do you:
 - A. Sit up straight?
 - B. Slouch or lean over your desk, lean back in your chair to be comfortable, or stay partly out of the seat?
20. When you are writing in your native language, which describes you best?
 - A. You spell words and write numbers correctly most of the time

- B. You sometimes mix up letters or numbers or write some words, letters, or numbers in reverse order or backward
21. When you are speaking in your native language, which is more like you?
- A. You speak words correctly and in the right order
 - B. You sometimes mix up words in a sentence or say a different one than what you mean, but you know what you mean
22. You usually:
- A. Stick to a topic when talking to people
 - B. Change the topic to something else you thought of related to it
23. You like to:
- A. Make plans and stick to them
 - B. Decide things at the last minute, go with the flow, or do what you feel like at the moment
24. You like to do
- A. Art projects in which you follow directions or step-by-step instructions
 - B. Art projects that give you freedom to create what you want
25. You like:
- A. to play music or sing based on written music or what you learned from others
 - B. to create your own music, tunes, or songs
26. You like to play or to watch:
- A. Sports that have step-by-step instructions or rules
 - B. Sports that allow you to move freely without rules
27. You like to:
- A. Work step-by-step, in order, until you get to the end product
 - B. See the whole picture or end product first and then go back and work the steps
28. Which describes you the best?
- A. You think about facts and events that really happened
 - B. You think in an imaginative and inventive way about what could happen or what could be created in the future
29. You know things because:
- A. You learn from the world, other people, or reading
 - B. You know them intuitively, and you can't explain how or why you know
30. You like to:
- A. Stick to facts
 - B. Imagine what could be

31. You usually:
A. Keep track of time
B. Lose track of time
32. You are:
A. Good at reading nonverbal communication
B. Not good at reading nonverbal communication
33. You are:
A. Better at directions given verbally or in writing
B. Better at directions given with pictures or maps
34. You are better at:
A. Being creative with existing materials and putting them together in a new way
B. Inventing or producing what is new and never existed
35. You usually work on:
A. One project at a time, in order
B. Many projects at the same time
36. In which of the following environments would you prefer to work?
A. A structured environment where everything is orderly, someone is telling you what to do, a time schedule is kept, and you do one project at a time, step-by-step and in order
B. An unstructured environment where you have freedom of choice and movement to work on what you want, where you can be as creative and imaginative as you want, keep your belongings any way you want, and do as many projects as you wish simultaneously, without any set time schedule

TOTAL ANSWERS MARKED A ONLY: _____

TOTAL ANSWERS MARKED B ONLY: _____

TOTAL ANSWERS MARKED BOTH A AND B: _____

Your preferred hemispheric preference is: _____

Appendix B

SCORING INSTRUCTIONS FOR THE LEARNING STYLES PREFERENCE AND THE HEMISPHERIC PREFERENCE TESTS

Learning Styles Assessment:

Total the scores for each letter of the assessment. If you gave more than one answer for any question, include all of the choices in the total for each letter.

TOTAL A: _____ If A is highest, you are VISUAL

TOTAL B: _____ If B is highest, you are AUDITORY

TOTAL C: _____ If C is highest, you are TACTILE

TOTAL D: _____ If D is highest, you are KINESTHETIC

Also note your second, third, and least preferred learning styles. Some people have developed several or all learning styles, and two, three, or all four styles may be tied.

Brain Hemispheric Preference Assessment:

Score one point for each question you answered with only A and write the total: _____
If your highest score is A, you prefer the LEFT HEMISPHERE.

Score one point for each question you answered with only B and write the total: _____
If your highest score is B, you prefer the RIGHT HEMISPHERE.

Score one point for each question you answered with both A and B and write the total: _____
If your highest score is in both A and B (tied), you are INTEGRATED.

If you have almost the same number of checks for A and B (not including the tied A and B column), you may have a MIXED preference and are using each side of the brain for different functions.

If your scores for the single A and the single B are within 1-2 points of each other, you have a MIXED preference favoring the (A/LEFT, B/RIGHT) hemisphere.

Bibliography

1. Critchlow, Keith, *“Islamic Patterns”*, Inner Traditions, Vermont, USA, 1976.
2. Grube, Ernst, J., et al, *“Architecture of the Islamic World”*, Thames and Hudson, London, 2002.
3. Hemingway, Priya, *“Divine Proportion”*, Sterling Publishing, New York, 2005.
4. Linksman, Ricki, *“How to Learn Anything Quickly”*, Barnes & Noble Books, New York, 1996.
5. Livio, Mario, *“The Golden Ratio”*, Headline Book Publishing, London, 2002.
6. Tannenbaum, Peter, *“Excursions in Modern Mathematics”*, Pearson/Prentice Hall, NJ, 2004.